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color different from that of the other; or by means of parallel vision, look with the right eye at a background of one color, with the left at one of another color. When the color of the left field is predominant, no after-image will be visible; when the right predominates, the image will be seen upon it.¹

In the above experiments it will be seen that whatever be done to the left eye, the after-image suffers no change, except that of being brightened by diminishing the brilliancy of the left field, and dimmed or destroyed by increasing it. But whenever the right eye is interfered with in various ways, the image suffers corresponding modifications. These differences cannot be explained if we suppose the seat of the after-image to be cerebral. They are all easily explainable if the seat is retinal. M. Binet and others have made the great mistake of supposing that whatever they might see in the field of the left eye when it alone is open, is seen by that eye. That this is not necessarily so, and that in the phenomena presented by this experiment it is not possibly so, has been shown by the above facts.

EDMUND B. DELABARRE.

Energy and Vision. S. P. LANGLEY. Am. Jour. of Science, 3d Series. Vol. XXXVI, p. 359.

Professor Langley has made a fresh determination of the brightness of the different portions of the spectrum. The investigation was made with great care, with a high sun, and errors from all possible sources were calculated and eliminated. The method chosen, after trial of others, was to determine how far away a screen carrying a portion of a table of logarithms had to be pushed in order for the figures to be just legible. The light from a slit, after passing through a collimating lens and a prism, was received on a silvered concave mirror, which formed a spectrum 90 mm. long in front of a second slit. Any color could be made to pass through this slit by setting a graduated circle; it then fell upon a black screen, through a hole in which, 1 cm. square, the table of logarithms was visible. The room was absolutely dark, and the position of the screen was got, by feeling notches, to within a centimeter. A variation of intensity of 225 times was had by the sliding screen alone. By changing the first slit and by introducing a photometer wheel, a variation a thousand times greater could be obtained. The selective absorption of silvered glass had been before determined by an ingenious method, and was now allowed for.

The results obtained are not easily compared with those of former observers (without making a graphical construction), for Langley's observations are taken at every .05 micron of wave-length, and those of Fraunhofer and Vierordt (the ones usually referred to) at Fraunhofer lines; but it seems plain that Professor Langley himself and his other three observers differ much more from each other

¹It will be interesting to apply the following as yet untried test when a sufficiently sensitive hypnotic patient can be found who can obtain good after-images, but who has himself no theory as to "cerebral" or "retinal" seats. Let him obtain with the right eye a strong after-image, and then by suggestion paralyze completely the sight of that eye. If, then, no after-image is seen with the other eye open, it will prove that the cerebral center has nothing to do with the production of the image; if, however, the image is perceived, it will merely indicate that the paralysis of the right optic nerve has not been complete, and the experiment will have proved nothing.

than from Vierordt. The following table gives the results (for the non-normal spectrum) for Prof. Langley, another observer (*a*), and Vierordt, the two former reduced to 1000 for yellow, for the sake of the comparison :

	45	50	55	60	65	70
(<i>a</i>)	151	156	1000	996	208	16
V.	128	370	1000	780	128	22
L.	64	774	1000	141	13	2

These values of Vierordt are for points very near the wave-length at the head of the columns. Vierordt's method was to measure the amount of white light that had to be added to a given color to make the color undistinguishable. Capt. Abney's curve agrees closely with Prof. Langley's.

Prof. Langley has made use of his admirable determination of the distribution of energy in the solar spectrum to obtain the brightness per energy of the different colors. The mean of his three observers, exclusive of himself, is as follows :

Color,	Violet.	Blue.	Green.	Yellow.	Orange.	Red.	Crimson.
Wave-length,	40	47	53	58	60	65	75
Luminosity,	1.6	62,000	100,000	28,000	14,000	1200	1

That is to say, crimson light from the end of the spectrum has to have 100,000 times more energy than green in order to give enough light to enable us to read by it. The absolute work done by that crimson is .001 of an erg, and by the green .00000001 of an erg.

It is not quite plain why Prof. Langley should definitively set down the green as the brightest part of the spectrum, on the testimony of his three observers (he has drawn the curve for only two of them), when he himself, Capt. Abney, and all former observers, beginning with Newton (who says that yellow and orange affect the senses more strongly than all the rest of the prismatic colors together), have considered the brightest part to be in the yellow. Prof. Langley himself suggests that young eyes may be more effective towards the blue end of the spectrum than older ones. C. L. F.

Ueber die Unterschiedsempfindlichkeit des normalen Auges gegen Farbentöne im Spectrum. Dr. W. UHTHOFF. Archiv für Ophthalmologie, XXXIV, 4, pp. 1-15.

The sensitiveness of the eye to the change of color produced by a given change of wave-length has been investigated before by Aubert, and more recently by Mandelstamm and by Dobrowolsky. The last two made use of Helmholtz's ophthalmometer without the eyepiece ; both plates were lighted up by monochromatic light, and one was then rotated until a difference of color was just perceptible. Dobrowolsky, by means of two Nicols with a quartz plate between them, caused both colors to be of equal intensity, a precaution which is particularly necessary near the ends of the spectrum. They found two points of maximum sensitiveness, one at *D* and one at *F'* ; the fraction of its wave-length by which a color had to be changed in order to seem changed was three times as great for green as for yellow or blue, and at the ends of the spectrum it was greater still. B. O. Peirce (*Am. Jour. of Science*, Oct. 1883) obtained a similar curve. König and Dieterici, by the method of mean errors and a different apparatus, got a curve which differs chiefly in rising very